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(54) **CABLE STORAGE APPARATUS AND CABLE PROCESSING METHOD**

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(73) Assignee: **NEC Corporation**, Toyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(30) **Foreign Application Priority Data**

Feb. 21, 2000 (JP) 2000-042561

(51) **Int. Cl.**[7] **B65H 75/30**; B65H 75/38

(52) **U.S. Cl.** ..... **242/388.1**; 242/388.7; 242/390.9; 242/396.5; 242/402; 191/12.2 A

(58) **Field of Search** ..... 242/388, 388.1, 242/388.2, 388.3, 388.5, 388.6, 388.7, 390.8, 390.9, 402, 396.5, 413, 413.4, 413.5; 191/12.2 A, 12.4

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Primary Examiner—John M. Jillions
(74) *Attorney, Agent, or Firm*—Sughrue Mion, PLLC

(57) **ABSTRACT**

A reel which is driven by a motor is disposed in a casing. First and second restraining mechanisms for restraining movement of a cable are located at first and second openings formed in the casing for insertion of the cable. The cable extends between said first and second openings and is wound around the reel. One end of the cable is secured by the first restraining mechanism, and the motor is activated to rotate the reel, thereby winding the cable around the reel. When a pressure sensor located on the surface of the reel detects that the pressure between the cable and the reel reaches a given value, the motor is stopped. The other end of the cable is secured by the second restraining mechanism.

9 Claims, 4 Drawing Sheets

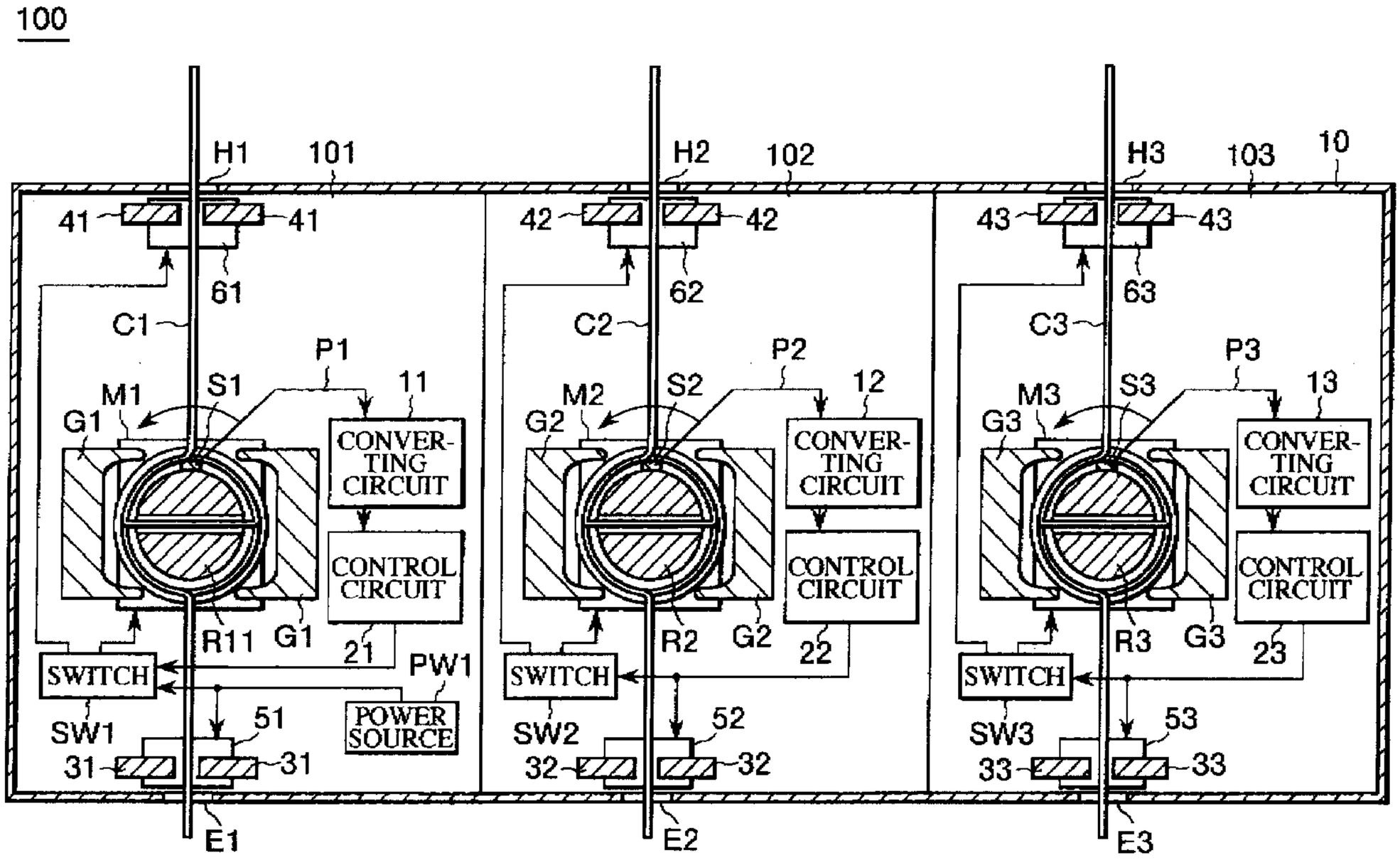


FIG. 1

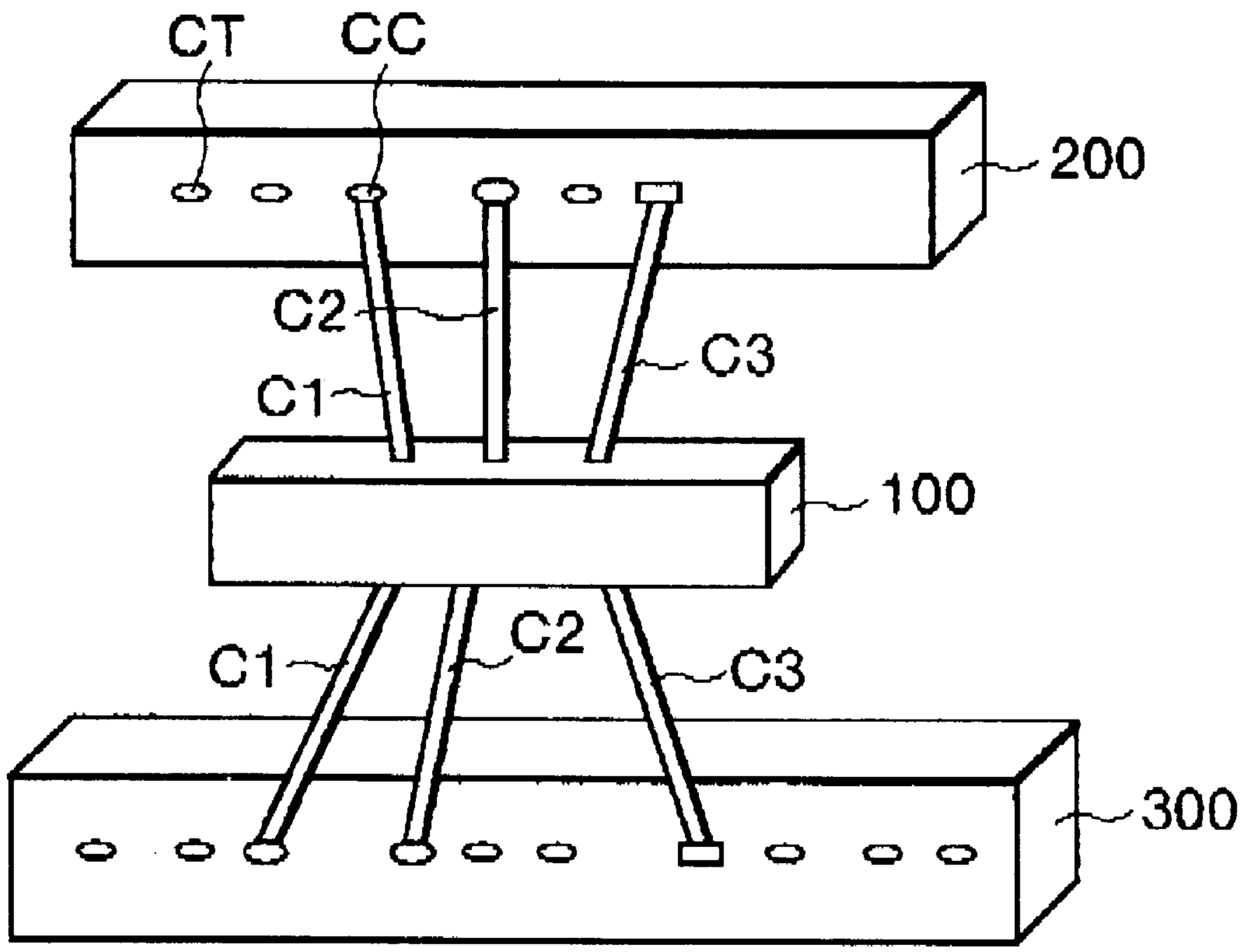


FIG. 2

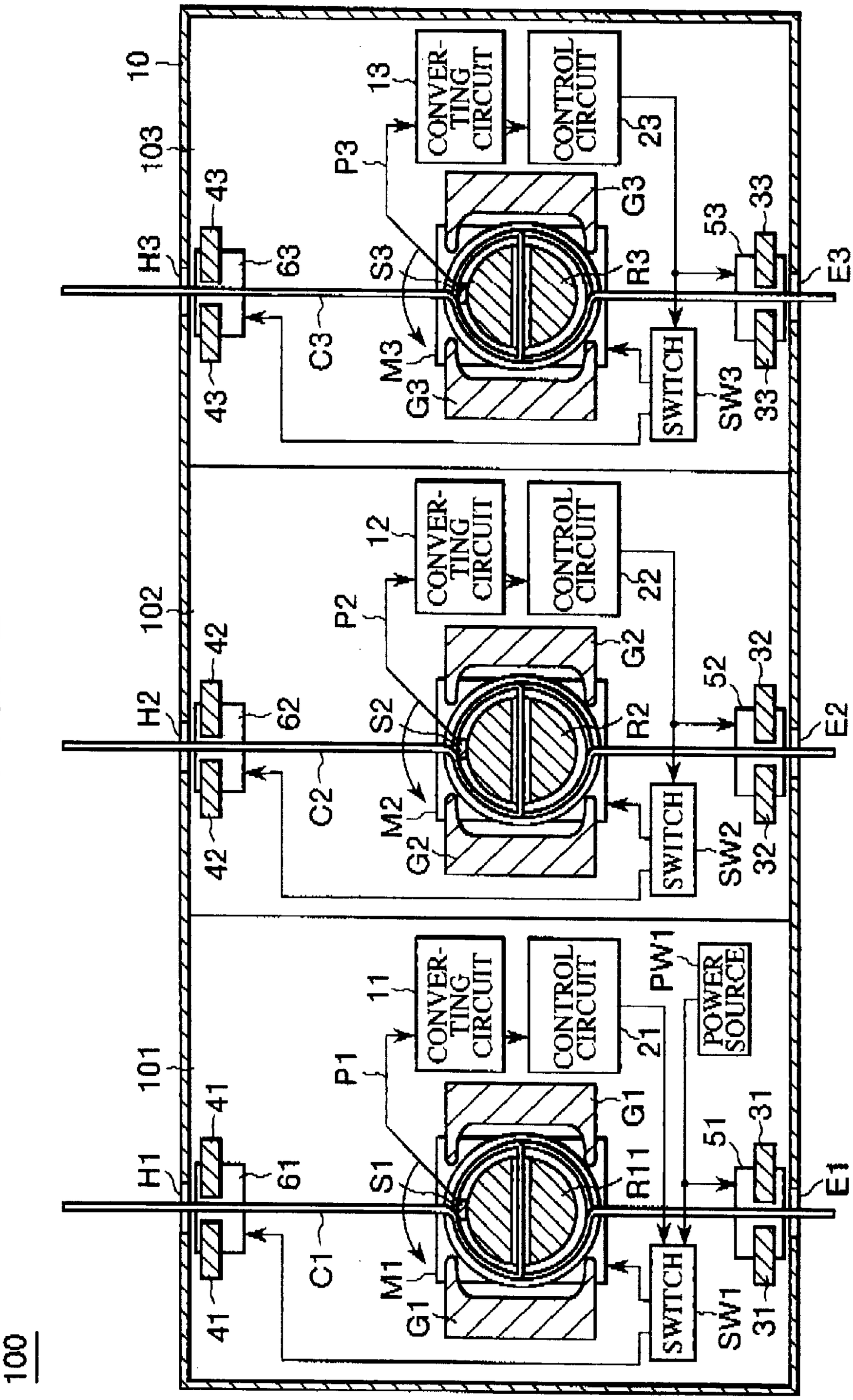

100
101
102
103
10
CONVER-TING CIRCUIT
CONTROL CIRCUIT
POWER SOURCE
PW1
11
12
13
21
22
23
P1
P2
P3
H1
H2
H3
41
42
43
61
62
63
C1
C2
C3
S1
S2
S3
M1
M2
M3
G1
G2
G3
R11
R2
R3
31
32
33
51
52
53
E1
E2
E3
SWITCH
SW1
SW2
SW3

FIG. 3

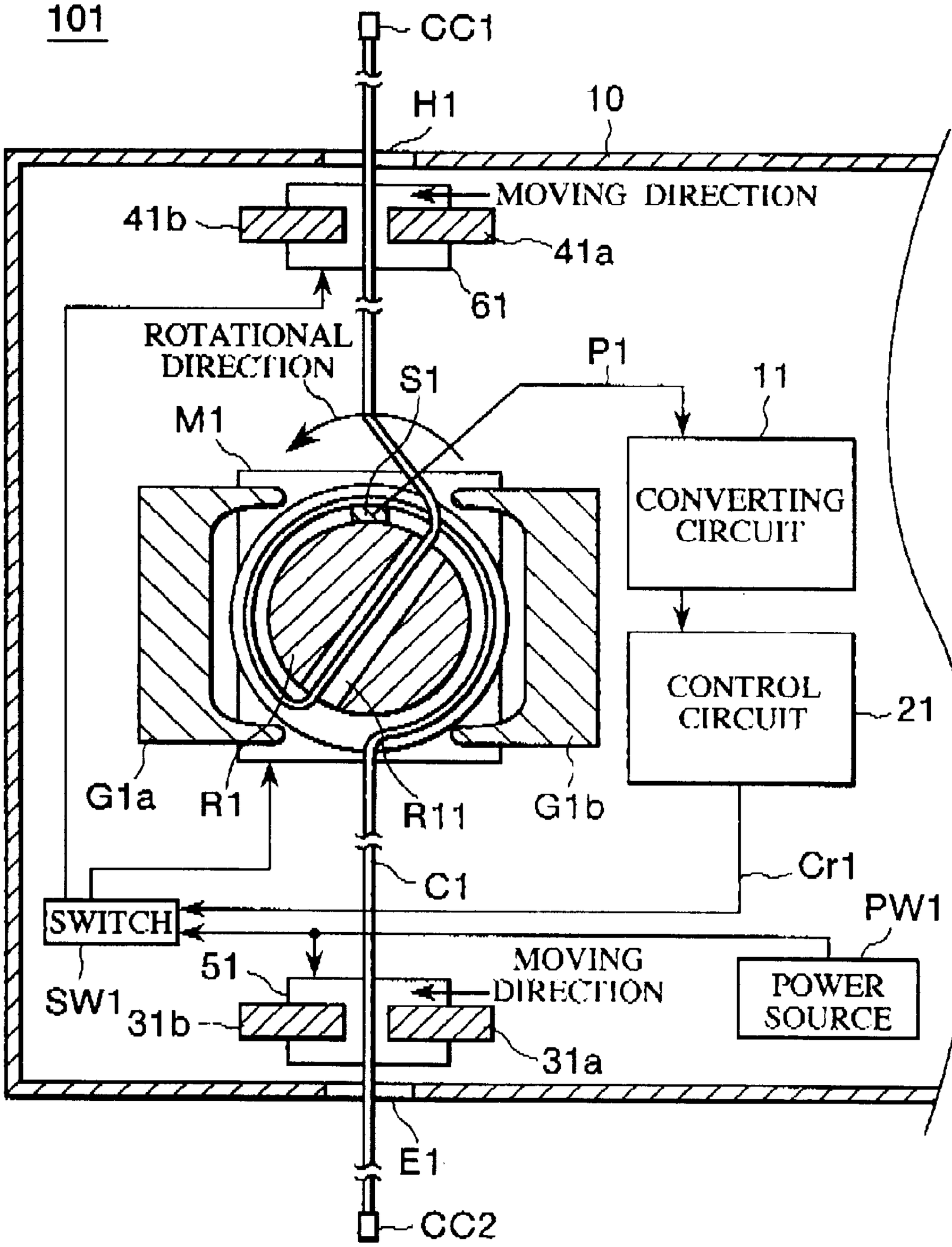
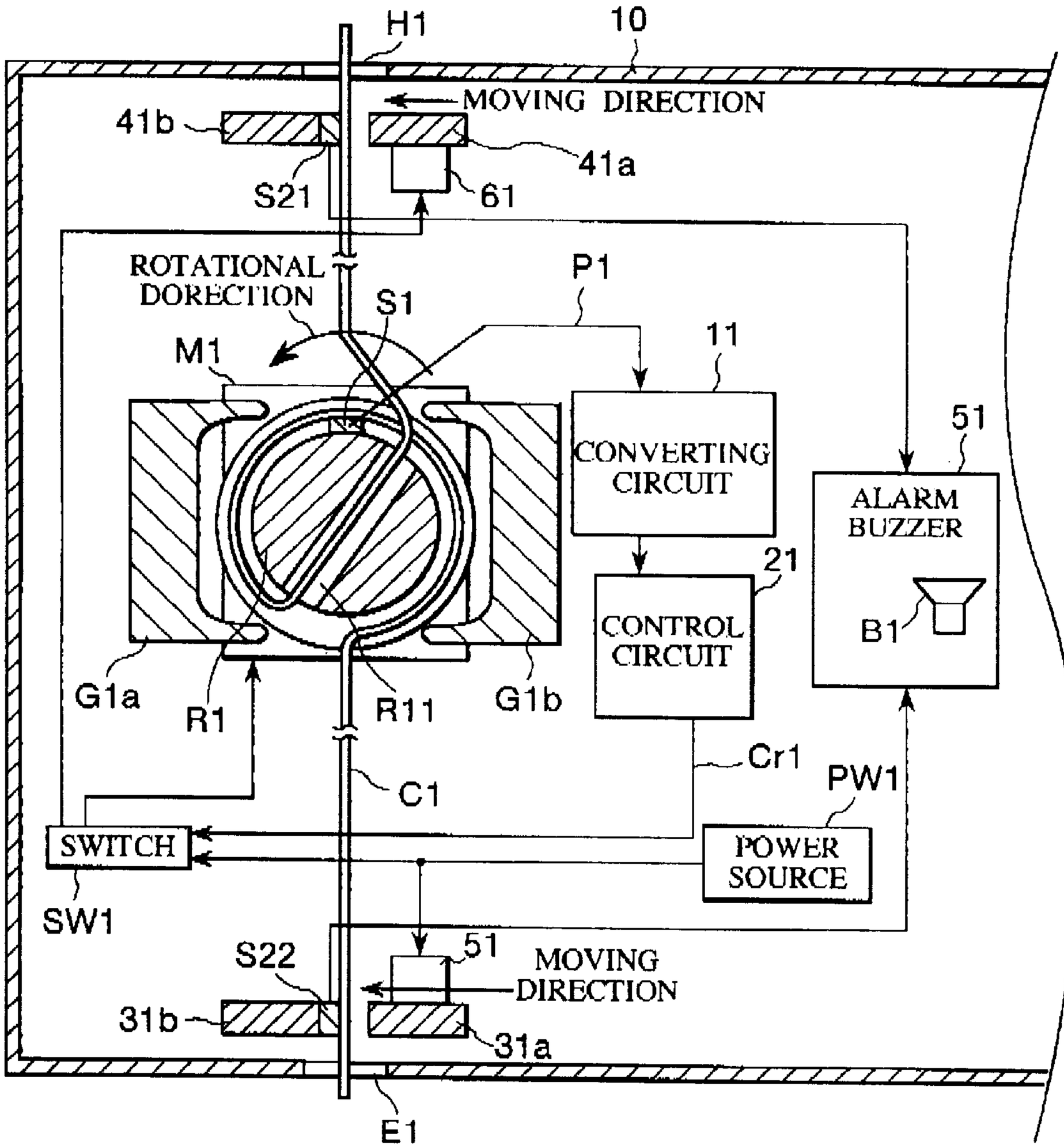

101
CC1
H1
10
MOVING DIRECTION
41b
41a
61
ROTATIONAL DIRECTION
S1
P1
11
M1
CONVERTING CIRCUIT
CONTROL CIRCUIT
21
G1a
R1
R11
G1b
C1
Cr1
SWITCH
PW1
51
MOVING DIRECTION
POWER SOURCE
SW1
31b
31a
E1
CC2

FIG. 4


H1
10
MOVING DIRECTION
41b
41a
S21
61
ROTATIONAL DORECTION
P1
S1
11
M1
CONVERTING CIRCUIT
51
ALARM BUZZER
21
CONTROL CIRCUIT
B1
G1a
R1
R11
G1b
Cr1
C1
PW1
SWITCH
POWER SOURCE
SW1
S22
51
MOVING DIRECTION
31b
31a
E1

CABLE STORAGE APPARATUS AND CABLE PROCESSING METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a cable storage (retaining) apparatus and a cable processing method, which retain the surplus portions (surplus lengths) of cables at the time a plurality of electronic devices are connected by the cables.

2. Description of the Related Art

A plurality of electronic devices are normally connected by cables. In some cases, however, it is difficult to identify which connectors are connected by which cable. Without processing the surplus portion (surplus length) of a cable (surplus length processing), the cable hangs down loosely. further, the weight of the hung cable itself applies stress on the connectors or the like. As cables are likely to be laid disorderly, the layout looks poor and the working environment where electronic devices are to be handled is apt to become poor.

Unexamined Japanese Patent Application KOKAI Publication No. H5-152770 discloses a cable apparatus which can overcome those problems. The disclosed cable apparatus can retain a part (surplus portion) of a cable in the casing. This cable apparatus however requires that a user should determine the length of the surplus portion of a cable and retain the surplus portion in the casing himself or herself. This work is troublesome and inconvenient.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a cable storage apparatus and a cable processing method which can automatically adjust the length of the surplus portion of a cable.

It is another object of the invention to provide a cable storage apparatus and a cable processing method which are easy to use.

To achieve the above objects, according to the first aspect of the invention, there is provided a cable storage apparatus comprising:

a casing;

a cable having both ends respectively to be connected to connectors;

a reel which is disposed in the casing and around which the cable is to be wound;

a winding mechanism which winds the cable by rotating the reel;

a pressure sensor which measures a pressure on the cable; and

a control circuit which controls winding of the cable by the winding mechanism when the pressure measured by the pressure sensor becomes equal to or higher than a predetermined value.

The pressure sensor is located on, for example, a cable winding surface of the reel and measures a pressure of the cable acting on the cable winding surface.

For example, a first opening and a second opening are formed in the casing and a first and second restraining mechanisms which restrains movement of the cable are arranged in the casing near the first and second openings.

A cable through hole may be formed in the reel, penetrating a circular side surface of the reel perpendicularly to a rotary shaft of the reel. In this case, the winding mechanism has a motor whose rotary shaft is coaxial to the rotary shaft

of the reel, and the cable is led through the first opening of the casing, is put through the cable through hole of the reel, is wound on the circular side surface of the reel and is then led out from the second opening of the casing.

With the cable secured by the first restraining mechanism and not by the second restraining mechanism, for example, the reel is rotated by the motor to wind the cable around the reel, and when the pressure sensor detects a predetermined pressure, the motor is stopped and the cable is secured by the second restraining mechanism.

The cable storage apparatus may further comprise a sensor which detects that tension of the cable becomes equal to or lower than a predetermined value, and an alarm circuit which generates an alarm in response to detection of the sensor.

To achieve the above objects, according to the second aspect of the invention, there is provided a cable storage apparatus comprising:

a casing having two openings formed for insertion of a cable;

a reel which is disposed in the casing and around which the cable extending between the two openings is to be wound;

a winding mechanism which winds the cable by rotating the reel;

a pressure sensor which measures a pressure on the cable; and

a control circuit which controls winding of the cable by the winding mechanism when the pressure measured by the pressure sensor becomes equal to or higher than a predetermined value.

To achieve the above objects, according to the third aspect of the invention, there is provided a cable processing method comprising:

securing a cable, led into a casing through a first opening formed in the casing, put through a hole formed perpendicular to a rotary shaft of a reel, wound on a side surface of the reel and led out from a second opening formed in the casing, at one of the first and second openings;

winding the cable around the reel by rotating the reel; and

detecting force applied to the cable, and stopping rotating the reel and securing the cable at the second opening when the force applied to the cable reaches a predetermined value.

Tension on the cable may be detected so that an alarm is generated when the tension becomes equal to or smaller than a predetermined value.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view illustrating how a cable storage apparatus embodying the present invention is used;

FIG. **2** is a structural diagram of a cable storage apparatus according to a first embodiment of the invention;

FIG. **3** is a diagram showing the detailed structure of a storage section of the cable storage apparatus shown in FIG. **2**; and

FIG. **4** is a diagram showing the detailed structure of a storage section of a cable storage apparatus according to a second embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described with reference to the accompanying drawings.

FIG. **1** illustrates how a cable storage apparatus **100** according to the first embodiment of the invention is used.

Electronic devices **200** and **300**, such as a computer and studio equipment, are to be connected together by cables C**1**, C**2** and C**3**.

The cables C**1**–C**3** are, for example, multi-core cables with connectors CC attached to both sides of each cable. Each connector CC is connected to a connector CT located on the electronic device **200** or **300**. The cable storage (retaining) apparatus **100** automatically takes up the surplus portions (loose portions) of the cables C**1**, C**2** and C**3** so that the electronic devices **200** and **300** are connected together by the cables C**1**–C**3** which are hardly loose.

FIG. **2** is a diagram showing the structure of the cable storage apparatus **100**. FIG. **2** shows the mechanical parts of the cable storage apparatus **100** in a cross-sectional view and an electric circuit in a block diagram.

As shown in FIG. **2**, the cable storage apparatus **100** has storage sections **101** to **103** for taking up and retaining the cables C**1**–C**3**, respectively.

As the storage sections **101**–**103** have approximately the same structures, the structure and operation of the storage section **101** as a representative will be discussed below.

Symbols having the same alphabets with different numerals are used to denote those components of the storage sections **102** and **103** which are the same as the corresponding components of the storage section **101**.

As shown in enlargement in FIG. **3**, the storage section **101** comprises a casing **10**, a converting circuit **11**, a control circuit **21**, a cable restraining mechanism **31** (**31***a* and **31***b*), a cable restraining mechanism **41** (**41***a* and **41***b*), constant torque motors **51** and **61**, a motor M**1**, a reel R**1** and a guide section G**1** (G**1***a* and G**1***b*).

An opening E**1** for insertion of one end of the cable C**1** is formed in one side of the casing **10**, and an opening H**1** for insertion of the other end of the cable C**1** is formed in the opposite side of the casing **10** to the former side.

The cable restraining mechanism **31** is located in the casing **10** near the opening E**1**. The cable restraining mechanism **31** comprises movable pieces **31***a* and **31***b* that are driven by the constant torque motor **51**.

The cable restraining mechanism **41** is located in the casing **10** near the opening E**1**. The cable restraining mechanism **41** comprises movable pieces **41***a* and **41***b* that are driven by the constant torque motor **61**.

The reel R**1** has a cylindrical or columnar outer shape with frames on upper and lower end faces as seen above the sheet of FIG. **3**, and is formed of metal or plastics. A through hole R**11** for the cable C**1** is formed in the circular side surface of the reel R**1**, penetrating perpendicularly to the rotary shaft of the reel R**1**. The inside diameter of the hole R**1** is made large enough to freely pass the cable C**1** (less friction with the cable C**1**).

The motor M**1**, which drives the reel R**1**, is so arranged that its rotary shaft is coaxial to the rotary shaft of the reel R**1**.

Further, a pressure sensor S**1** is attached to the side surface of the reel R**1**. The motor M**1** is provided with a fixed stand which has a ring-like conductor (ring conductor or slip ring). The output terminal of the pressure sensor S**1** comes in a movable contact with the ring-like conductor which provides the output of the pressure sensor S**1**.

To make winding of the cable C**1** around the circular side surface of the reel R**1** easier, guides G**1***a* and G**1***b* have such walls as to be concentric to the reel R**1** and serve to guide the cable C**1**.

The pressure sensor S**1** outputs a signal P**1** corresponding to the pressure applied to the sensor S**1** or the pressure that is applied to the side surface of the reel R**1** by the cable C**1** wound around the reel R**1**. The converting circuit **11** converts the signal level of the signal P**1** and sends the resultant signal to the control circuit **21**.

The control circuit **21** compares the pressure that is indicated by the signal output from the converting circuit **11** with a preset reference pressure P**1**th. When the pressure detected by the pressure sensor S**1** (the pressure of the wound cable C**1** that presses the side surface of the reel R**1**) becomes equal to or higher than the reference pressure P**1**th, the control circuit **21** sends a switch SW**1** with a control signal Cr**1** for stopping the rotation of the motor M**1**.

A power source PW**1** supplies power to the switch SW**1** and the constant torque motor **51**. Upon reception of the power from the power source PW**1**, the constant torque motor **51** drives the movable pieces **31***a* and **31***b* of the cable restraining mechanism **31** to hold and stop the cable C**1**. The switch SW**1** starts supplying power to the motor M**1**.

Upon reception of the control signal Cr**1**, the switch SW**1** stops supplying power to the motor M**1** and starts supplying power to the constant torque motor **61**. Then, the motor M**1** that winds the cable C**1** on the reel R**1** stops rotating and the movable pieces **41***a* and **41***b* of the cable restraining mechanism **41** hold and stop the cable C**1**. Note that the casing **10** is covered with a detachable lid. The lid is placed on the top side of the casing **10** as seen from above the sheets of FIGS. **2** and **3**.

The following will discuss how to use the cable storage apparatus **100** having the above-described structure.

The electronic devices **200** and **300** and the cable storage apparatus **100** are so laid that the cables C**1**–C**3** can be laid in order as shown in FIG. **1**. One end (connector CC**1**) of the cable C**1** is connected to the connector CT of the electronic device **200**. Next, the lid of the casing **10** (placed on the top side in FIG. **2**) is opened and the other end of the cable C**1** whose one end (connector CC**1**) is connected to the electronic device **200** is put through the opening H**1** of the storage section **101**. If there are cables C**2** and C**3** that should be connected to the electronic device **200**, the cables C**2** and C**3** are retained in the other storage sections **102** and **103** in the same procedures as mentioned above.

The other end of the cable C**1** led into the casing **10** through the opening H**1** is put through the hole R**11** of the reel R**1** and is led out through the opening E**1** of the casing **10**. In this state, one end of the cable C**1** is stretched to the adequate length and the cable C**1** is wound on the circular side surface of the reel R**1** by about one turn. Then, the reel R**1** is manually turned clockwise a little so that the cable C**1** makes approximately one turn (see FIG. **3**). At this time, the guide section G**1** serves to guide the cable C**1** so that the cable C**1** is easily taken up on the reel R**1**, and forms the winding of the cable C**1** on the reel R**1**.

The other end (connector CC**2**) of the cable C**1** that is led out through the opening E**1** is connected to the connector CT of the electronic device **300**. The length of the cable C**1** whose other end (connector CC**2**) is connected to the electronic device **300**, between the electronic device **300** and the opening E**1**, is manually adjusted to the adequate length. After the adjustment, the power source PW**1** is turned on. As a result, the power from the power source PW**1** is supplied to the constant torque motor **51**. This activates the constant torque motor **51** to cause the cable restraining mechanism **31** (comprising the two pieces **31***a* and **31***b*) to hold the cable C**1** with a constant torque. The constant torque of the cable

restraining mechanism **31** prevents the cable C**1** from being damaged and from moving inside and outside the casing **10**.

Further, the power is supplied to the motor M**1** via the switch SW**1**. The motor M**1** rotates the reel R**1** counterclockwise. The rotation of the reel R**1** causes the cable C**1** to be wound on the circular side surface of the reel R**1** with the proper forming by the guide section G**1**.

At the beginning of the winding of the cable C**1**, the cable C**1** is not taken up on the reel R**1** even when the reel R**1** rotates, and the cable C**1** between the reel R**1** and the cable restraining mechanism **31** and the cable C**1** between the reel R**1** and the cable restraining mechanism **41** become loose slightly. As the rotation of the reel R**1** continues, however, the winding of the cable C**1** on the reel R**1** starts. In this case, the other end of the cable C**1** is held securely by the cable restraining mechanism **31**, so that the cable C**1** slides between the reel R**1** and the guides G**1***a* and G**1***b* while being wound on the reel R**1**. When the reel R**1** takes up one end side of the cable C**1** by a certain amount, the cable C**1** starts applying a pressure on the circular side surface of the reel R**1**. When the length of the cable C**1** between the electronic device **200** on one end side of the cable C**1** and the opening H**1** becomes an adequate length, the predetermined pressure P**1**th is applied to the pressure sensor S**1**.

The pressure sensor S**1** sends the converting circuit **11** with the signal P**1** that indicates the pressure applied to the circular side surface of the reel R**1**. The converting circuit **11** converts the signal level of the signal P**1** and sends the resultant signal to the control circuit **21**. Upon reception of the electric signal indicative of the pressure corresponding to the pressure P**1**th, the control circuit **21** sends the control signal Cr**1** to the switch SW**1**. In response to the control signal Cr**1**, the switch SW**1** stops supplying power to the motor M**1** to stop rotating the motor M**1** and starts supplying power to the constant torque motor **61**. The constant torque motor **61** drives the movable pieces **41***a* and **41***b* of the cable restraining mechanism **41** to hold the cable C**1** and restrains the further movement of the cable C**1** into the casing **10**.

The above-described sequence of operations causes the surplus portion of the cable C**1** to be retained in the storage section **101**. Therefore, the lengths of the cable C**1** between the electronic device **200** and the storage section **100** and between the electronic device **300** and the storage section **100** are adjusted to the adequate lengths. The storage sections **102** and **103** have the same capabilities as that of the storage section **101**, so that the cable storage apparatus **100** promotes the automation of orderly surplus length processing with respect to diverse cable connections of information devices and AV (Audio and Visual) devices.

It is to be noted that the sizes and strengths of reels R**2** and R**3**, sensors S**2** and S**3** and two kinds of cable restraining mechanisms **32**, **33** and **42**, **43**, and predetermined pressures to be detected are designed in accordance with the types of cables to be wound around the reels.

Motors M**2** and M**3**, switches SW**2** and SW**3** and openings E**2**, E**3**, H**2** and H**3** in the storage sections **102** and **103** are likewise designed in accordance with the types of cables to be wound around the reels.

FIG. **4** presents a structural diagram of a storage section **101**A of a cable storage apparatus **100**A according to another embodiment of the invention. The cable storage apparatus **100**A has a capability of detecting detachment (coming off) of the connectors that are connected to the electronic devices **200** and **300** in FIG. **1** and generating an alarm when such detection is made. The storage section **101**A will be discussed below with reference to FIG. **4**. Same symbols are given to those components in FIG. **4** which are the same as the corresponding components in FIG. **3**.

The movable piece **41***b* of the cable restraining mechanism **41** in the storage section **101** A has a tension sensor S**21** provided at its distal end portion which holds the cable C**1**. The movable piece **31***b* of the cable restraining mechanism **31** has a tension sensor S**22** provided at its distal end portion which holds the cable C**1**.

The tension sensors S**21** and S**22** respectively measure tension T**1** of that portion of the cable C**1** which lies on that side of the electronic device **200** and tension T**2** of that portion of the cable C**1** which lies on that side of the electronic device **300**. When the connector CC**1** or CC**2** of the cable C**1** comes off the connector CT of the electronic device **200** or **300**, the tensions T**1** and T**2** of the cable C**1** fall. The output signals of the tension sensors S**21** and S**22** are sent to an alarm buzzer circuit **51**. The alarm buzzer circuit **51** discriminates the amount of reduction in tension that is indicated by the signal supplied from the tension sensor S**21** or S**22** and determines whether or not the reduction amount is equal to or greater than a predetermined reference value T**1**th. If the reduction amount of tension is equal to or greater than the reference value T**1**th, a buzzer generates an alarm.

Suppose the connector that is connected to one end of the cable C**1** comes off the electronic device **200** in the state shown in FIG. **4**. Then, the tension of one end of the cable C**1** drops rapidly, so that the tension detected by the tension sensor S**22** falls sharply. If the tension drops from T**1** to T**11**, the amount of reduction ΔT becomes T**10**–T**11**. The alarm buzzer circuit **51** compares this reduction amount ΔT with the reference value T**1**th. When the reduction amount ΔT is equal to or greater than the reference value T**1**th, the alarm buzzer circuit **51** drives the buzzer B**1**, warning a user of the disconnection of the cable C**1**.

The invention is not limited to the above-described embodiments, but may be modified and adapted in various other forms.

For example, the structures of the cable restraining mechanisms **31** and **41** are not limited to the above-described structures, and may be so designed that the movable pieces take the form of an elastic member, such as a spring, to press a cable with the force of the elastic member and the pressing is released by an actuator. The cable restraining mechanisms may be so designed as not to use movable pieces. The position where the pressure sensor S**1** is attached is not limited to the side surface of the reel R**1** but can be set arbitrarily.

The motor for driving the reel may be controlled based on the tension of a cable. For instance, the motor M**1** may be driven to wind the cable on the reel until the tension reaches a given value. When the tension drops sharply, an alarm is buzzed.

The number of cables that are processed by the cable storage apparatus is not limited to three, but may be set to any number.

Various embodiments and changes may be made thereunto without departing from the broad spirit and scope of the invention. The above-described embodiments are intended to illustrate the present invention, not to limit the scope of the present invention. The scope of the present invention is shown by the attached claims rather than the embodiments. Various modifications made within the meaning of an equivalent of the claims of the invention and within the claims are to be regarded to be in the scope of the present invention.

This application is based on Japanese Patent Application No. 2000-042561 filed on Feb. 21, 2000 and including specification, claims, drawings and summary. The disclosure of the above Japanese Patent Application is incorporated herein by reference in its entirety.

What is claimed is:

1. A cable storage apparatus comprising:

a casing;

a cable having both ends respectively to be connected to connectors;

a reel which is disposed in said casing and around which said cable is to be wound;

a winding mechanism which winds said cable by rotating said reel;

a pressure sensor which measures a pressure on said cable; and

a control circuit which controls winding of said cable by said winding mechanism when said pressure measured by said pressure sensor becomes equal to or higher than a predetermined value.

2. The cable storage apparatus according to claim **1**, further comprising:

a sensor which detects that tension of said cable becomes equal to or lower than a predetermined value; and

an alarm circuit which generates an alarm in response to detection of said sensor.

3. A cable storage apparatus comprising:

a casing;

a cable having both ends respectively to be connected to connectors;

a reel which is disposed in said casing and around which said cable is to be wound;

a winding mechanism which winds said cable by rotating said reel;

a pressure sensor which measures a pressure on said cable; and

a control circuit which controls winding of said cable by said winding mechanism when said pressure measured by said pressure sensor becomes equal to or higher than a predetermined value,

wherein said pressure sensor is located on a cable winding surface of said reel and measures a pressure of said cable acting on said cable winding surface.

4. A cable storage apparatus comprising:

a casing;

a cable having both ends respectively to be connected to connectors;

a reel which is disposed in said casing and around which said cable is to be wound;

a winding mechanism which winds said cable by rotating said reel;

a pressure sensor which measures a pressure on said cable; and

a control circuit which controls winding of said cable by said winding mechanism when said pressure measured by said pressure sensor becomes equal to or higher than a predetermined value,

wherein a first opening and a second opening are formed in said casing and a first and second restraining mechanisms which restrain movement of said cable are provided in said casing near said first and second openings.

5. The cable storage apparatus according to claim **4**, wherein a cable through hole is formed in said reel, penetrating a circular side surface of said reel perpendicularly to a rotary shaft of said reel;

said winding mechanism has a motor whose rotary shaft is coaxial to said rotary shaft of said reel; and

said cable is led through said first opening of said casing, is put through said cable through hole of said reel, is wound on said circular side surface of said reel and is then led out from said second opening of said casing.

6. The cable storage apparatus according to claim **5**, wherein with said cable secured by said first restraining mechanism and not by said second restraining mechanism, said reel is rotated by said motor to wind said cable around said reel; and

when said pressure sensor detects a predetermined pressure, said motor is stopped and said cable is secured by said second restraining mechanism.

7. A cable storage apparatus comprising:

a casing having two openings formed for insertion of a cable;

a reel which is disposed in said casing and around which said cable extending between said two openings is to be wound;

a winding mechanism which winds said cable by rotating said reel;

a pressure sensor which measures a pressure on said cable; and

a control circuit which controls winding of said cable by said winding mechanism when said pressure measured by said pressure sensor becomes equal to or higher than a predetermined value.

8. A cable processing method comprising:

securing a cable at one of a first and a second opening formed in a casing, wherein said cable is led into said casing through said first opening formed in said casing, put through a hole formed perpendicular to a rotary shaft of a reel, wound on a side surface of said reel and led out from said second opening formed in said casing;

winding said cable around said reel by rotating said reel; and

detecting force applied to said cable,and stopping rotating said reel and securing said cable at said opening when said force applied to said cable reaches a predetermined value.

9. The cable processing method according to claim **8**, wherein tension on said cable is detected and an alarm is generated when said tension becomes equal to or smaller than a predetermined value.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,454,202 B2
DATED : September 24, 2002
INVENTOR(S) : Takeharu Ito

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 3,
Line 51, delete "hole R1" insert -- hole R11 --

Signed and Sealed this

Twenty-first Day of January, 2003

JAMES E. ROGAN
Director of the United States Patent and Trademark Office